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Studies in Canada's Arctic

Fisheries Research Board of Canada 1970

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Fisheries Research Board of Canada 1970
Miscellaneous Special Publication 13

FRB Studies in Canada's Arctic

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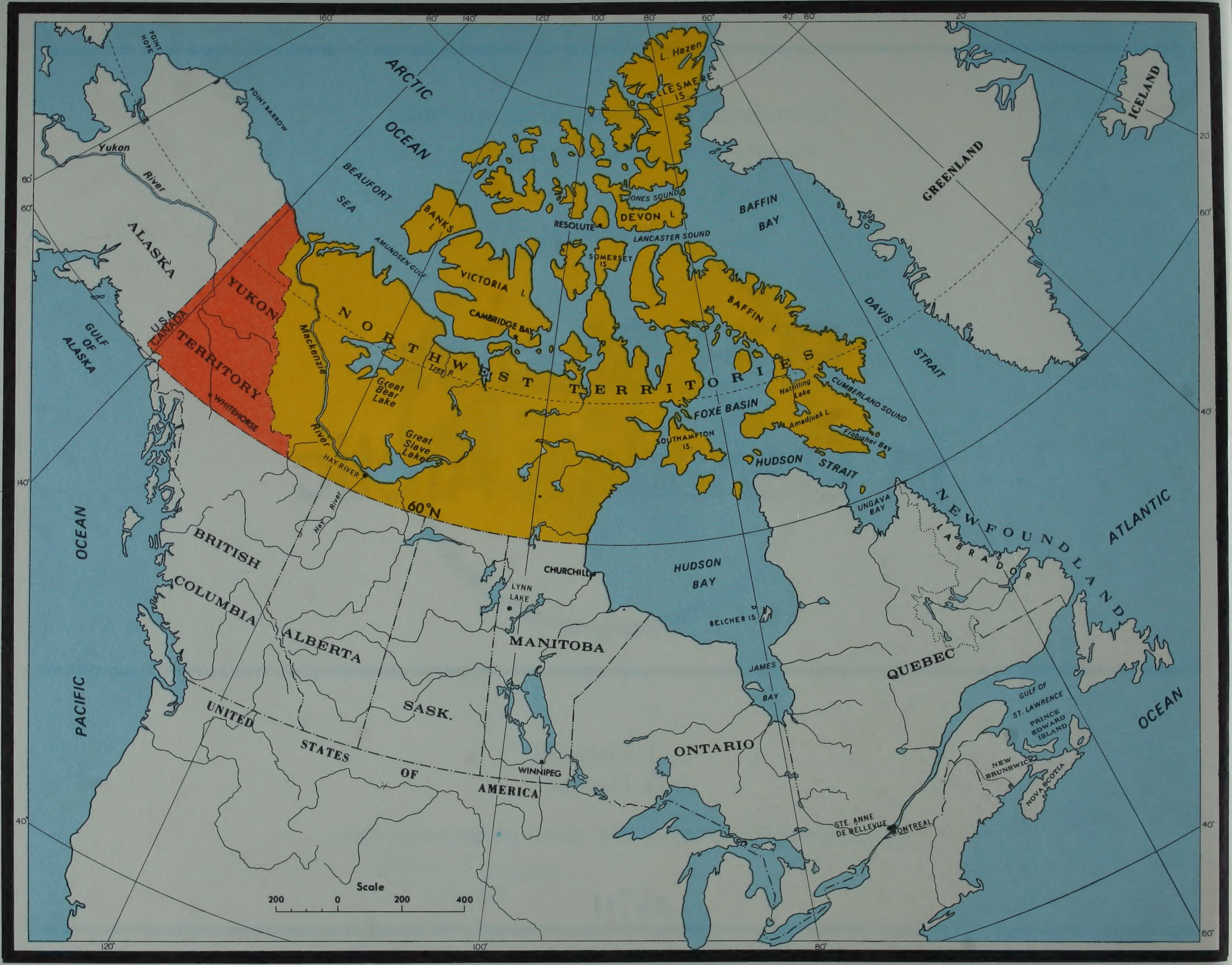
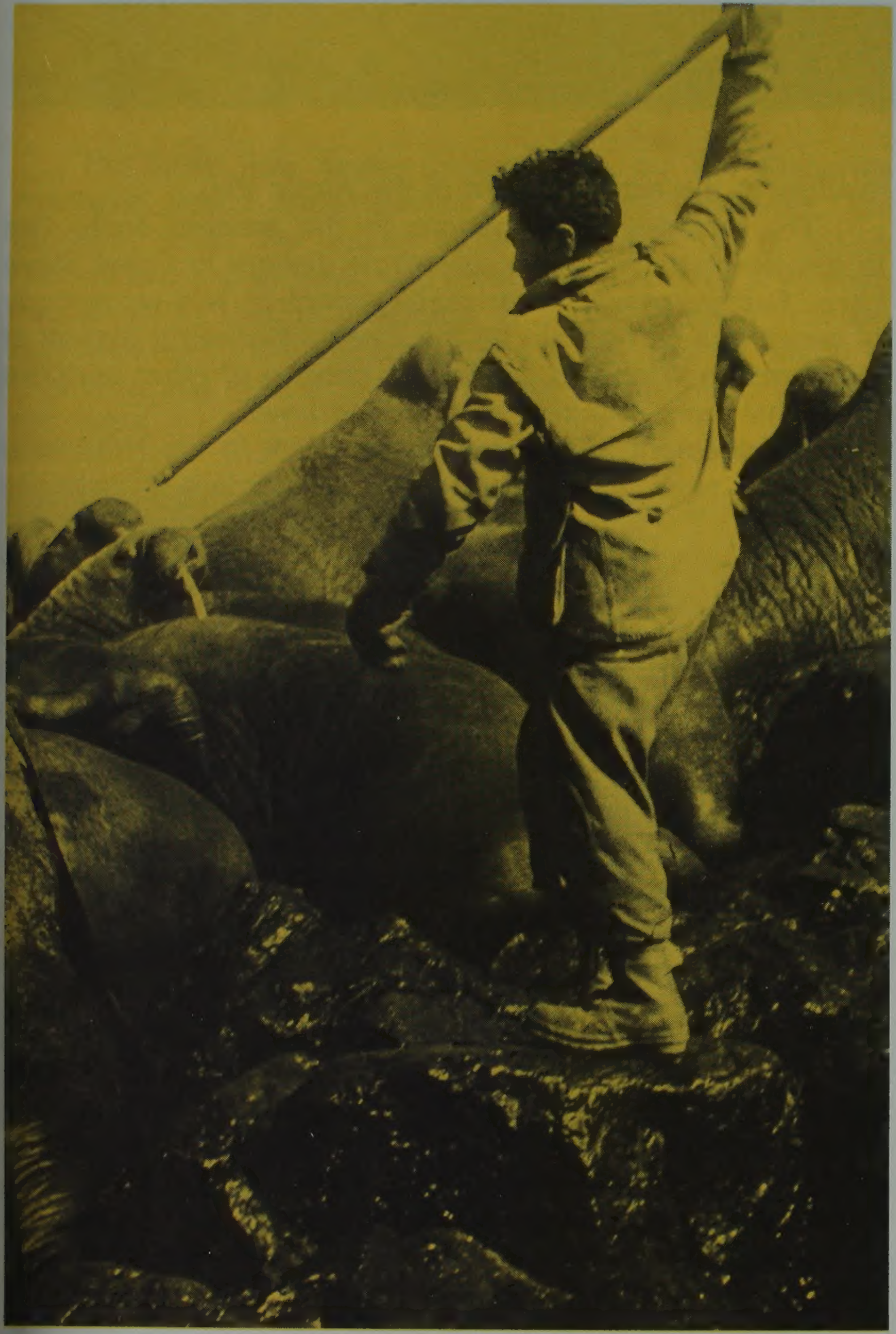


CANADA, HIGHLIGHTED NORTH OF 60°, WITH PLACE NAMES USED IN TEXT



A northern resident assists in "tagging" a herd of walrus

FRB STUDIES IN CANADA'S ARCTIC

Biological investigations of aquatic renewable resources in Arctic Canada have been sponsored or conducted by the Fisheries Research Board of Canada since 1944. For the first few years the work was mainly by university professors and their students. In 1955 the Arctic Unit was established with headquarters in Montreal and responsibility for research on aquatic biological resources of most of the Canadian Arctic. In 1964 it was renamed "Arctic Biological Station" and relocated at Ste. Anne de Bellevue. Investigation of the freshwater fishes was transferred to the Freshwater Institute, Winnipeg, in 1967 and the Arctic Biological Station continued to be responsible for Canadian research on marine and anadromous fish and biological oceanography in northern waters, as well as marine mammals on all coasts.

Although a vast geographical area is involved, entailing extremely difficult logistics, full-time scientific staff of the Arctic Biological Station has never exceeded nine. But over the past 15 years their efforts have been largely responsible for inventories of arctic marine mammals and fishes, and of primary and secondary production, as outlined in this report.

The estimates of potential yields of various species of mammals and fish have been used extensively by management to develop northern fisheries, both commercial and recreational.

HISTORY

The earliest biological reports from the Canadian Arctic were those of naturalists and others accompanying expeditions in search of a northern route to the Orient, and of occasional amateurs among the fur traders who collected specimens or recorded their observations. Samuel Hearne, after his trip to the Arctic Ocean in 1789, was among the first to report anything substantial.

Further information followed from accounts of missionaries, R.C.M.P. patrols and eventually scientific investigations. Canadian scientists and naturalists contributed to this early information, particularly during the Canadian Arctic Expedition of 1913-1918, and through scientific personnel sent on survey trips by the Department of Marine and Fisheries. Direct activity by the Fisheries Research Board (then the Biological Board of Canada) did not occur until the late 1920's, when a scientist was assigned to the annual arctic supply trips. This practice continued for a few years, and was followed in 1930 by a specific investigation to collect biological, hydrographic and fisheries resource information from Hudson Bay.

Plans formulated in 1938 by the Fisheries Research Board to investigate the fisheries resources of the entire Canadian Arctic were shelved during the war. However, a general survey of the freshwater and anadromous fisheries in the western Arctic was sponsored in 1944 and 1945, one of the leaders being the late Dr. D. S. Rawson of the University of Saskatchewan. This survey was followed by a 9-year investigation of the marine resources of the eastern Arctic, begun in 1947 under Dr. M. J. Dunbar of McGill University. This investigation was expanded to include all the aquatic biological resources of most of the Canadian Arctic and resulted in the establishment of the Arctic Unit.

The fisheries investigations in the western Arctic led to the development of a commercial fishery in Great Slave Lake. Further research for management of this large body of water was carried out by the Central Research Station of the Board in Winnipeg, as well as surveys of other northern lakes that were required from time to time.

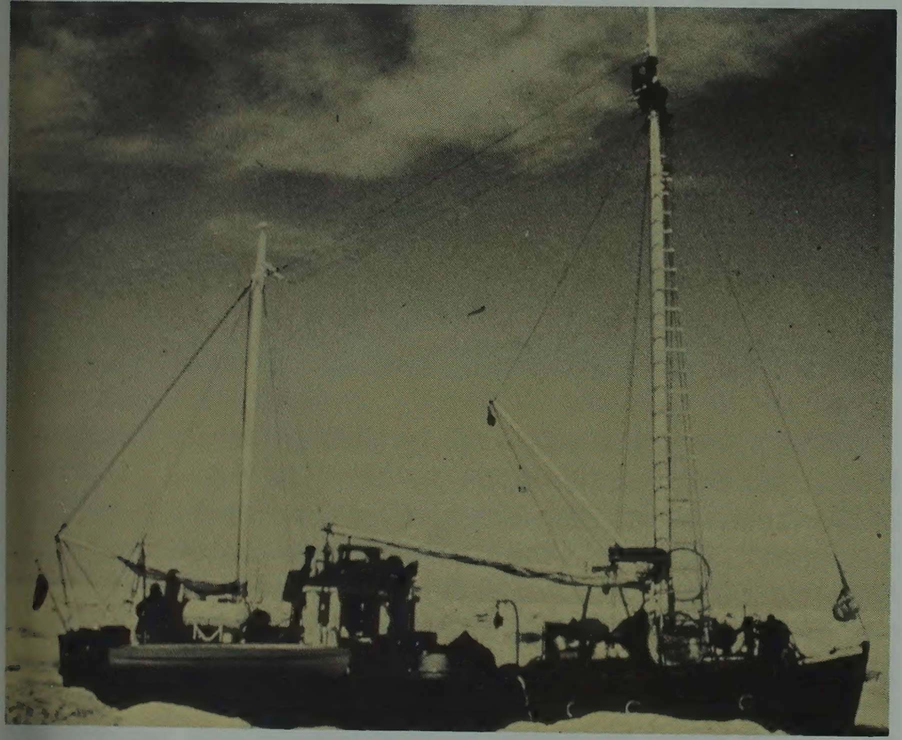
Management and policy enforcement in the Northwest Territories were undertaken by the Department of Fisheries of Canada, from an office in Hay River, under the Area Director in Winnipeg. Subsequently the Department of Fisheries opened another office in Whitehorse, Y.T., under the Pacific Area Director, but continued to manage the resources of the central Arctic from Winnipeg and Lynn Lake, Manitoba. In 1962 the Department sent officers into the high Arctic as commercial and sports fisheries developed.

In 1967 the Freshwater Institute in Winnipeg took over investigation of arctic freshwater fishes from the Arctic Biological Station, which continued to be responsible for Canadian research on arctic marine and anadromous fish, biological oceanography and sea mammals.

Following the war and the rapid development accompanying installation of the Distant Early Warning (DEW) Line in the Arctic, the Department of Northern Affairs and National Resources organized fishing cooperatives, provided management personnel, along with freezers, nets, boats and markets for the produce, and worked closely with the Fisheries Research Board and the Department of Fisheries to develop the best possible harvesting and management practices.

AREA

The area now under investigation by the Fisheries Research Board encompasses the Yukon Territories, the Labrador coast, the marine waters of the Arctic, including Hudson and James bays, and areas of the northwest Atlantic frequented by marine mammals. This whole region includes approximately three million square miles, half of which is land area that in turn contains 53,000 square miles of lakes and rivers.

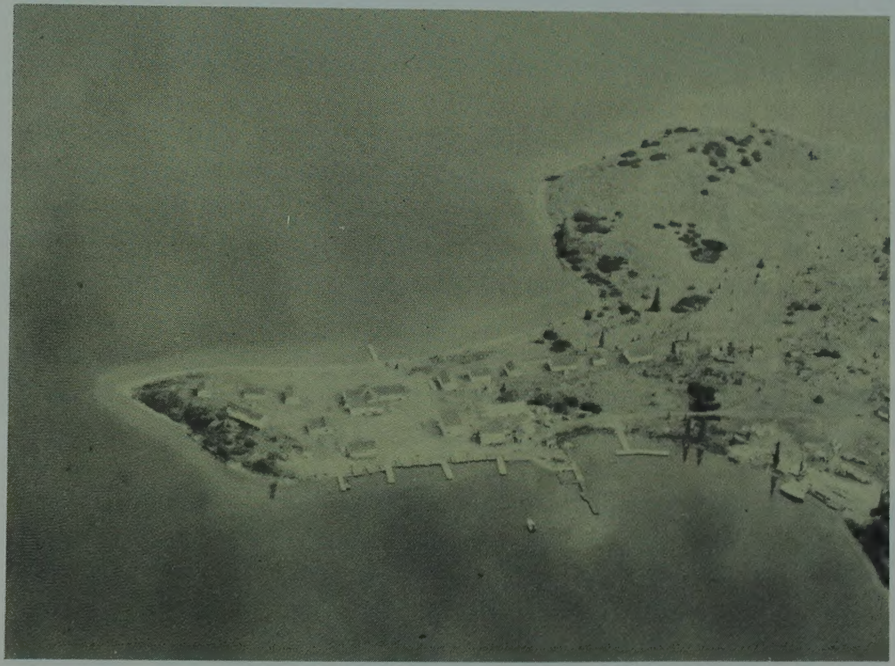


The FRB research vessel MV "Calanus" iced in for winter observations

TOPOGRAPHY

The land pattern changes markedly from east to west. The rugged mountains of northern Labrador and the eastern Arctic islands slope to the rocky exposed shield of eastern and central mainland Canada and adjacent islands, and this in turn to the central alluvial lowlands of the Mackenzie valley and the mountains of the west.

Lakes are largely confined to mainland shield and island lowland areas. All except Great Slave and Great Bear are shallow and all except those in the extreme eastern and western parts drain to Hudson Bay or the Arctic Ocean.



Lake trout angling camp on Great Bear Lake

PERMAFROST

Below a depth of approximately eight inches, the ground is permanently frozen north of a line approximating the mean July isotherm of 60°F, and this is the principal factor in maintaining the smaller surface water bodies and extensive bog areas throughout much of the Arctic. Disturbance of the vegetation usually disrupts the permafrost layer and so has deleterious effects on the physical and biological conditions associated with it, such as erosion and draining away of lakes.

CLIMATE

Long cold winters, short cool summers, and extremely low precipitation characterize the Arctic climate. Nevertheless, temperatures occasionally reach 90°F and as much as 3.5% of the land mass north of 60° Latitude is covered with lakes, rivers, and ponds maintained through the presence of permafrost.

For both marine and freshwater organisms the dominant feature of the Arctic climate is the long period of ice and snow cover, which may last for 8 to 10 months of the year.

ABORIGINAL PEOPLES AND BASIC ECONOMIES

The native peoples, Indians and Eskimos, live in two principal regions. Eskimos prefer coastal treeless areas while Indians live mainly in the inland wooded areas. Because of these habitat preferences the two peoples depend upon different animal species, and have different basic economies.

Marine mammals, particularly the ringed seal, have provided the essentials of life for most Eskimos, while terrestrial animals and the forest have supplied food, clothing and shelter to the Indians. However, in both cases, fish have proved an important resource that, like mammals, can be stockpiled during periods of abundance. Even today the native peoples, though irrevocably committed to modifying their culture, are heavily dependent upon stocks of seals, whales, walrus and fish for their personal needs. Besides harvesting furs they now sell surplus fish. This is done through the development of commercial and sport fisheries.

STUDIES ON RENEWABLE AQUATIC RESOURCES

The primary interest in the renewable aquatic resources is directed towards their optimum use. However, a great deal of diversified information is necessary to achieve or approach this state. Locations where studies were carried out from 1944 to 1969 are indicated in Figures 1*a* and 1*b*.

The results obtained from this work are available in published accounts, annual reports and interdepartmental correspondence related to management and development. A number of examples of published papers and reports are listed later in the text. Those aspects associated with production are summarized under principal subject headings.

LIMNOLOGY

The fresh waters of the Arctic have probably been altered less by man than any other major freshwater system in the world.

To date the northern waters have been relatively free from pollution, eutrophication, artificial impoundment or excessive fishing pressure. However, the situation is rapidly changing as population and industrial activities increase.

Most of the lakes and rivers in the Northwest Territories are of recent origin, having been formed during the retreat of the continental ice sheets. Deglaciation began about 10,000 years ago, and in some areas the land is still rebounding after release from the pressure of the ice. These recently formed waters have been populated mainly by plants and animals that moved in from the unglaciated regions of the northern United States, the Yukon and Alaska. In addition some of the plants and animals were originally marine forms and became adapted to fresh water as lakes were formed by elevation of the land in formerly marine areas.

Arctic lakes are as diverse in character as those of the more temperate regions. The depth and area of the basin, the chemical composition of the water and the temperature regime all combine to affect the biology of the plants and animals. In depth the lakes range from Great Slave Lake (2000 ft, 610 m) to shallow tundra pools; in area, from Great Bear Lake (11,583 sq. miles, 30,000 sq. kilometres) to ponds of a few square metres. Similarly the chemical composition varies from the rich lakes in the Cambridge Bay region of Victoria Island, with total dissolved solids up to 1000 parts per million, to the unproductive waters of Great Bear Lake and certain lakes of Somerset Island, where the dissolved materials amount to as little as 64 and 16 parts per million, respectively.

Temperatures in shallow ponds near the Arctic coast may reach 20°C in summer, but those of Great Bear Lake, though farther south, rarely exceed 4°C and Stanwell-Fletcher Lake on Somerset Island is free of ice only in exceptionally warm years. All these lakes have one thing in common: in winter they are warmer than the air above. In shallow lakes temperatures are 0°C or slightly above. In the deeper lakes bottom temperatures in winter may be as high as 3.6°C and vary by only a few hundredths of a degree throughout the year, thus providing one of the world's most constant environments.

Thus Arctic fresh waters provide habitats superficially similar to those of lakes in temperate regions. The important distinguishing features are the length of the period of low temperatures, and the distribution of sunlight and darkness in summer and in winter. These factors combine to reduce annual growth rates as conditions become more extreme: a long period of near dormancy is followed by a short period of continuous daylight and activity. In most animals this low rate of growth has resulted in increasing the age at which maturity is reached and the times between successive reproduction phases in those that reproduce more than once.

The low production of northern waters may allow pronounced increases in productivity when nutrients are added. Observations on two similar lakes at Resolute, Cornwallis Island, showed that when rather small amounts of sewage were added to one, the rate of basic production was 40 times that for the other. In a similar manner small amounts of deleterious substances could possibly produce equally pronounced reductions in the rates of production since the total biological matter present is so small that there is little capacity for the system to absorb such material and render it harmless.

BIOLOGICAL OCEANOGRAPHY

The Arctic seas, like the land and fresh waters, fall under the influence of pronounced climatic oscillations, and reflect the effects of seasonal variations in air temperature, sunlight, precipitation, and consequent sea-ice and snow cover. Production of the primary organisms (simple plants), virtually zero during most of the winter in the dark waters beneath the snow-covered sea-ice, begins with the first penetration of light through the ice as the snow cover melts in early summer. At this time potential light is maximal, and inorganic food sources have regenerated to their highest level for the year. Photosynthetic activity rapidly reaches its maximum, and the great bulk of annual primary production occurs fairly quickly — within a month. For short periods of time, primary producers and photosynthetic rates are high, at levels similar to those in temperate waters to the south. The period of activity, however, is short, and in terms of average quantity on hand for the year, or of total yearly production, Arctic values are low. Yearly net production may range from less than 10 grams of carbon under a square metre of sea surface in the Arctic Ocean to near 100 grams in the sea around south Baffin Island; and these figures may be compared with 200 to 400 grams in more southern regions of the temperate North Atlantic.

Quantities and probably annual production values of secondary producers (zooplankton) as well show similar differences between Arctic and temperate regions. Many of the principal zooplankters of cold waters require a full year or even two to complete a generation, whereas most temperate-water species complete several generations in a single year. This leads to even greater differences in annual production values than simple standing-stock comparisons would suggest.

Bottom-dwelling animals are plentiful in Arctic waters but their slow growth and longevity result in lower annual production for any given level of standing stock than occurs with their relatives in temperate regions.

The consequence of low production of both planktonic and benthic animals in the Arctic is that less food is produced per unit area for fishes and sea mammals that prey on them.

Limnological studies being conducted in arctic waters

FISHES

At least 150 species of fish, 35 from fresh water and the remainder from the sea, have been reported from the waters of northern Canada but only a few are of direct use to man.

Marine species, consisting of cod, capelin, herring and flatfish, are taken in small numbers and used locally by natives. Freshwater and anadromous species, consisting principally of salmonid fishes such as whitefish, ciscoes, lake trout and arctic char, are much more widely used and form the basis for domestic, commercial and sport fisheries. All are characterized by slow growth and/or small size.

The commercial fishery in Great Slave Lake, begun after the survey of the western Arctic in 1944-45, now yields about 0.75 lb per acre (0.84 kg/ha) annually. Further survey work in 1959 led to the policy that small lakes of the Territories be exploited at rates equivalent to 0.5 lb per acre (0.56 kg/ha) per year. To offset the cost of fishing small lakes at such low yields, a system of rotational fishing was organized whereby several years' quota could be removed from a lake in a short period of time. The lake was then to be left fallow for a number of years for the stocks to recover. Division of the lakes into an appropriate sequence of open and closed units provided continuous year to year fishing within an area.

In the region of the Mackenzie River, the stocks of fish are mainly migratory and these have been reserved to supplement the needs of the domestic fishery. On the other hand the Mackenzie delta, with its 5000 square-mile area of river courses, ponds and lagoons, contains both resident and migratory fish that are suitable for commercial exploitation. There are indications that productivity in this region is relatively high and that over 2.5 million pounds (1.1 million kg) of fish are available on an annual basis.

Several large lakes in the Arctic can support only small fisheries. These are Great Bear, Stanwell-Fletcher, Hazen, Nettilling and probably Amadjuak lakes. Sustainable annual production of fish from these waters is probably less than 0.3 lb per acre (0.34 kg/ha), though in general there is a large standing stock that can provide excellent fishing for a few years.

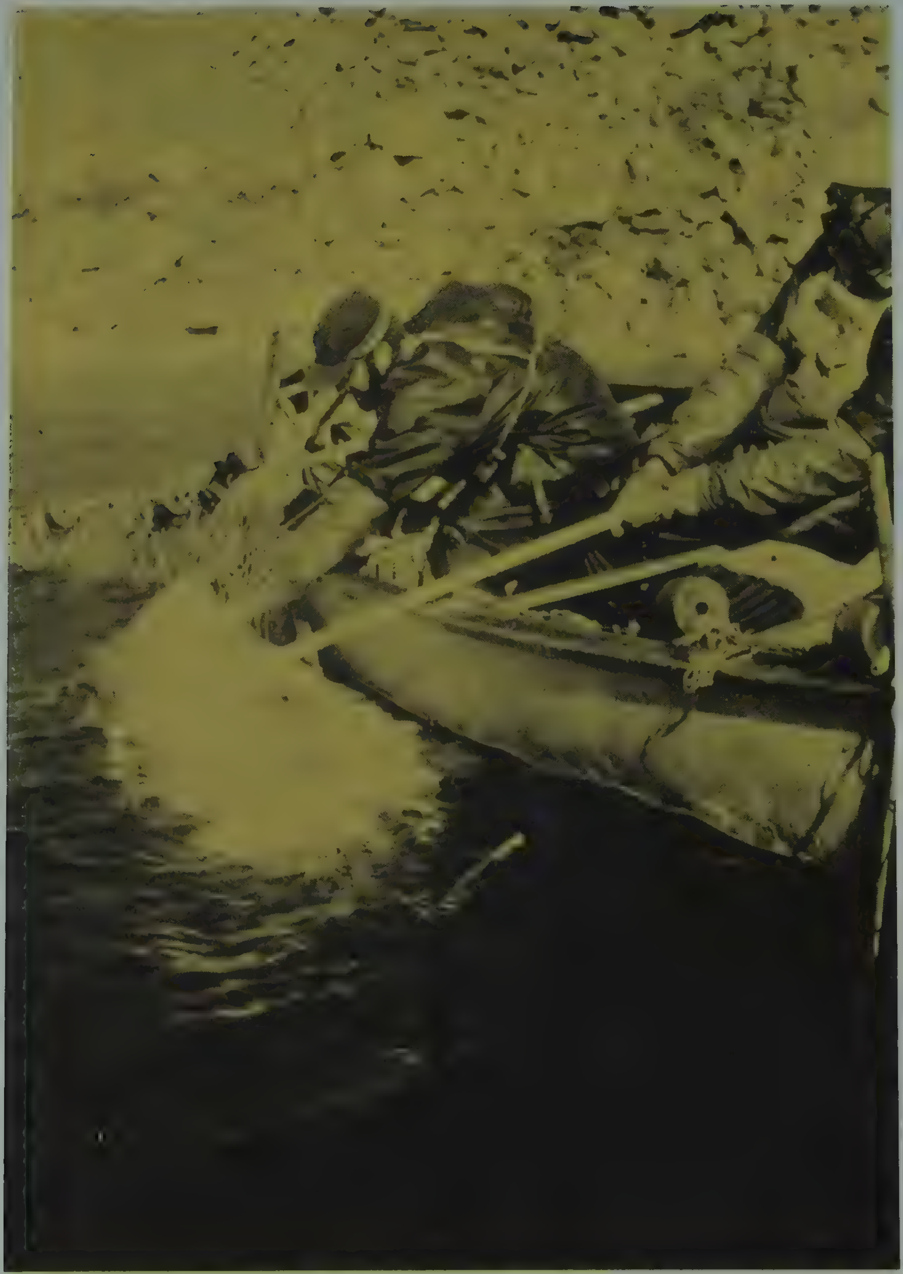
Anadromous arctic char are the most abundant fish of the northern coastal and island region. Their size and growth differ greatly over their range, as do their production rates. Annual yields, based upon the area of the freshwater habitat, of about 1 lb per acre (1.1 kg/ha) appear feasible from at least one river stock (Tree River). The landlocked char, though smaller, are common in small island lakes and may yield up to 5 lb per acre (5.6 kg/ha). Present catches of arctic char from commercial and sport fisheries in Canada total about 450,000 pounds annually.

Areas of potential marine fisheries are Hudson Strait, Ungava Bay and off the east coast of Baffin Island, where halibut, cod and redfish have been taken in trawl and longline samples. However, further test fishing is needed to assess this potential.

Most marine fish in the Arctic are small forms and are utilized as food by marine mammals and other fish. Seldom do these small fish weigh more than a few ounces, but preliminary estimates indicate for these alone a standing stock of more than a billion pounds (453 million kg).

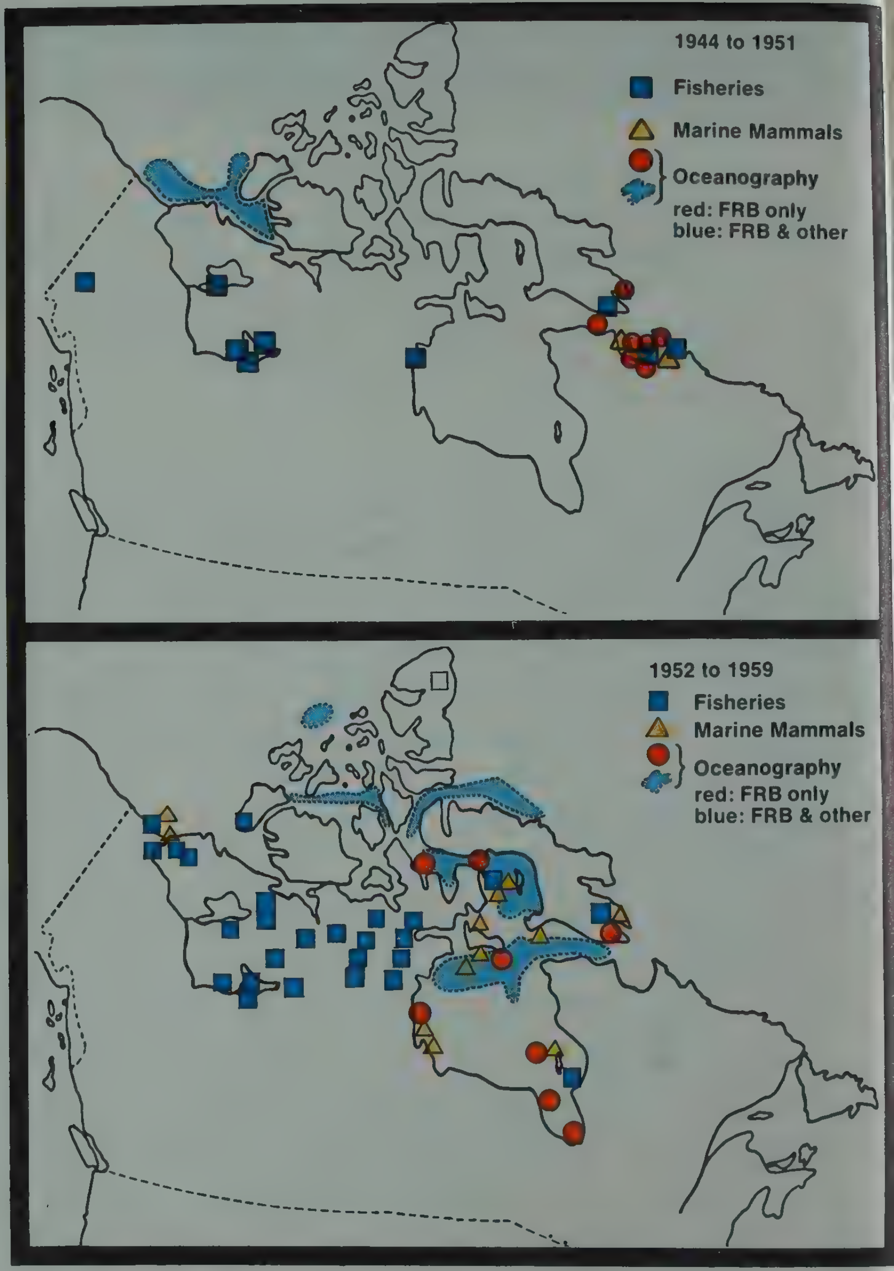
A summary of the potential and actual yields of freshwater, anadromous, and marine fish is shown in Figure 4.

While the yield of fish from Arctic waters is not great their importance to the local people is indicated in three graphs comparing fish production, fish utilization and human population in each of the Northwest Territories and Canada (Figure 2).



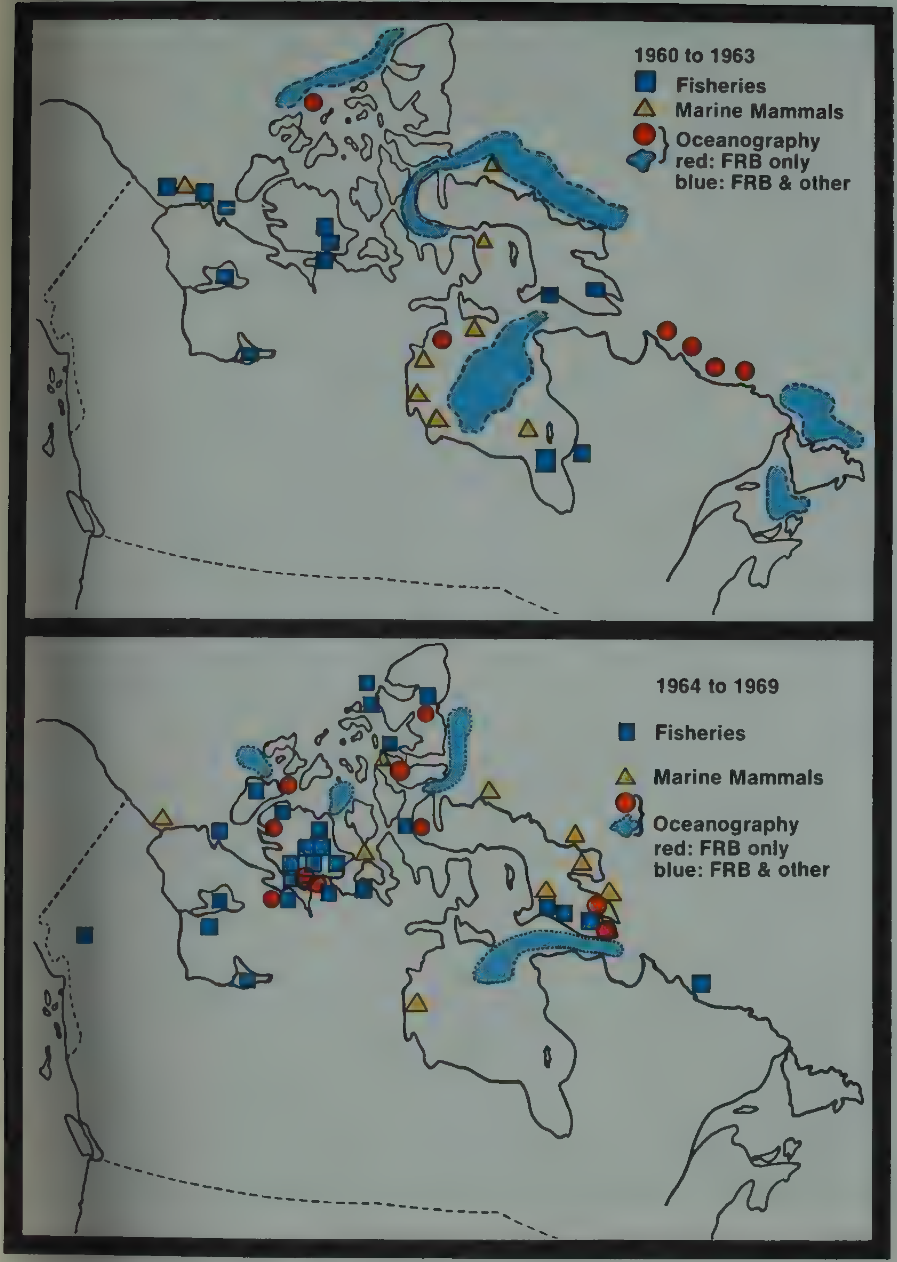
FRB scientists land narwhal for study

Figure 1a.



Localities of various Surveys and other Studies of the Fisheries Research Board

Figure 1b.



MARINE MAMMALS

Marine mammals are abundant throughout the Arctic. Distributions of the various species depend primarily on the availability of food, but may be limited by the presence of ice.

Ringed Seal

The ringed seal is the most successful species since it can live under fast ice throughout the winter and eats a wide range of food from bottom-living fishes and invertebrates to small pelagic crustaceans. It is abundant throughout the Arctic and forms the backbone of the Eskimo economy, supplying meat for men and dogs, skins for clothing and boots, and blubber for lamps.

The total population is estimated to number about two million, which would provide a maximum sustainable yield of about 160,000 seals annually. This potential crop has never been realized, principally because of the wide scattering of Eskimo settlements in the north. In some areas where Eskimos are concentrated there are signs of over-exploitation of the stocks.

In years when there has been a good demand for skins and when market prices have been high, as many as 70,000 have been traded, but in years of poor demand the number has dropped below 20,000, resulting in up to 90% loss of income to the Eskimos. Consumer preference, affected by sealing practices in other areas, has caused wide fluctuations of this sort in the last five years.

Bearded Seal

The bearded seal, or squareflipper, is a large solitary arctic seal which lives in the pack ice for much of the year and feeds on bottom invertebrates. It is highly prized by Eskimos for its tough flexible hide, used in making boot soles and rawhide line. Since it is taken only in small numbers, usually totalling less than 1000 per year, it is important only to the local economy.

Harp Seal

The harp seal is a large gregarious migratory seal which spends the summers from about June to November in eastern Arctic waters but appears in large breeding concentrations off southern Labrador and the Gulf of St. Lawrence between November and May. Food consists of planktonic crustaceans, squid, polar cod, capelin, herring and occasionally groundfish such as cod and plaice. Catch in the Arctic by Eskimos is incidental to the take of ringed and bearded seals although greater numbers could be taken by the use of simple stationary nets.

Walrus

The walrus is another animal of the pack ice which feeds on bottom invertebrates, particularly clams. It is nearly always found in small groups of up to 20 or so, but large numbers may congregate when the land is used as a resting place. It is a large animal equivalent in weight to about 10 ringed seals. It supplies chiefly meat for dog food, a need which is less critical since the advent of the snowmobile in most northern communities.

However, the demand for ivory is increasing and there will always be Eskimos willing to hunt this animal for the extra profit to be gained from the tusks.

The walrus does not appear to undertake extensive migrations but remains throughout the winter in areas of moving ice. At Southampton Island in northern Hudson Bay, an estimated population of 3000 walruses supplies the average annual local catch of 150, but little increase is possible owing to the low reproduction. In northern Foxe Basin a larger population is present which could probably support an increase in catch of 100 or 200 animals over the present annual catch of about 130.

Northern Hudson Bay and northern Foxe Basin are the two main centres of walrus distribution. Only small populations, probably numbering no more than a few hundreds in all, are found in other widely scattered localities from the Belcher Islands in the south to Ellesmere Island in the north.

White Whale

The white whale, or beluga, is common in western Hudson Bay, Cumberland Sound, Jones Sound and the Mackenzie delta.

It feeds on capelin, polar cod and a wide variety of bottom invertebrates and is highly prized by the Eskimos as a source of muktuk (the edible skin) and meat for dogs. It has been abundant enough to support a whale processing plant at Churchill for several years that took an average of 450 animals per year, mainly for oil, hides and mink food, and a net fishery further along the coast at Whale Cove which still continues and takes up to 200 whales per year. The products of this fishery are mainly muktuk, meat for men and dogs, oil, and canned foods such as pickled muktuk and steaks for distribution to other settlements in the Arctic.

The total catch of white whales in the eastern Arctic averages about 1000 and in the western Arctic about 200.

Landed white whales are studied by FRB scientists. The MV Calanus can be seen in background

Narwhal

The narwhal is mainly confined to north and east Baffin Island and the number taken per year seldom exceeds 200. It is known to feed on, among other things, pelagic squid, polar cod and Greenland halibut (turbot). It is a source of muktuk for Eskimos and meat for dogs, and the tusk of the male is valuable as an article of trade. Catches could be increased four or five times but the species is very difficult to hunt by boat. Nets have been used successfully, but capture by this means is time-consuming and expensive.

Bowhead Whale

The bowhead, or Greenland right whale, is now making a come-back after near extermination by commercial whalers in the latter part of the 19th century. Like most baleen whales, it feeds on planktonic organisms such as small crustaceans, small fish and fish larvae, and pelagic molluscs. The bowhead is still uncommon in the eastern Arctic, but in the west an annual migration regularly occurs from the Bering Sea to western Banks Island and Amundsen Gulf.

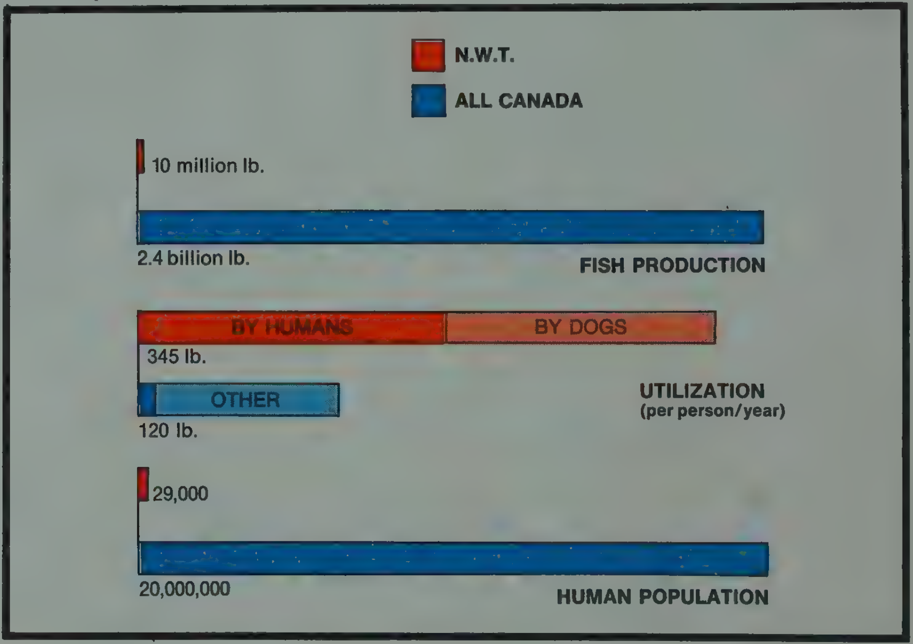
Under the rules of the International Whaling Commission, bowheads are completely protected from commercial exploitation, though they may be hunted if the meat and products are to be used exclusively for local consumption by the native people. About 10 are taken annually at Point Hope and Point Barrow in Alaska by Eskimos who hunt them from skin boats or *umiaks,* but no hunting is undertaken in Canada. Observations suggest that the population is increasing, but exploitation cannot be considered yet.

The actual and potential yields of the aquatic mammals other than bowhead whales are summarized in Figure 3.

It is well realized that there is need for much further research on both fish and marine mammals, especially to improve the population estimates. Such developments are planned by the Arctic Biological Station particularly for the ringed seal, arctic char and marine fishes such as the Greenland halibut, and by the Freshwater Institute for freshwater species of the numerous Territorial lakes.

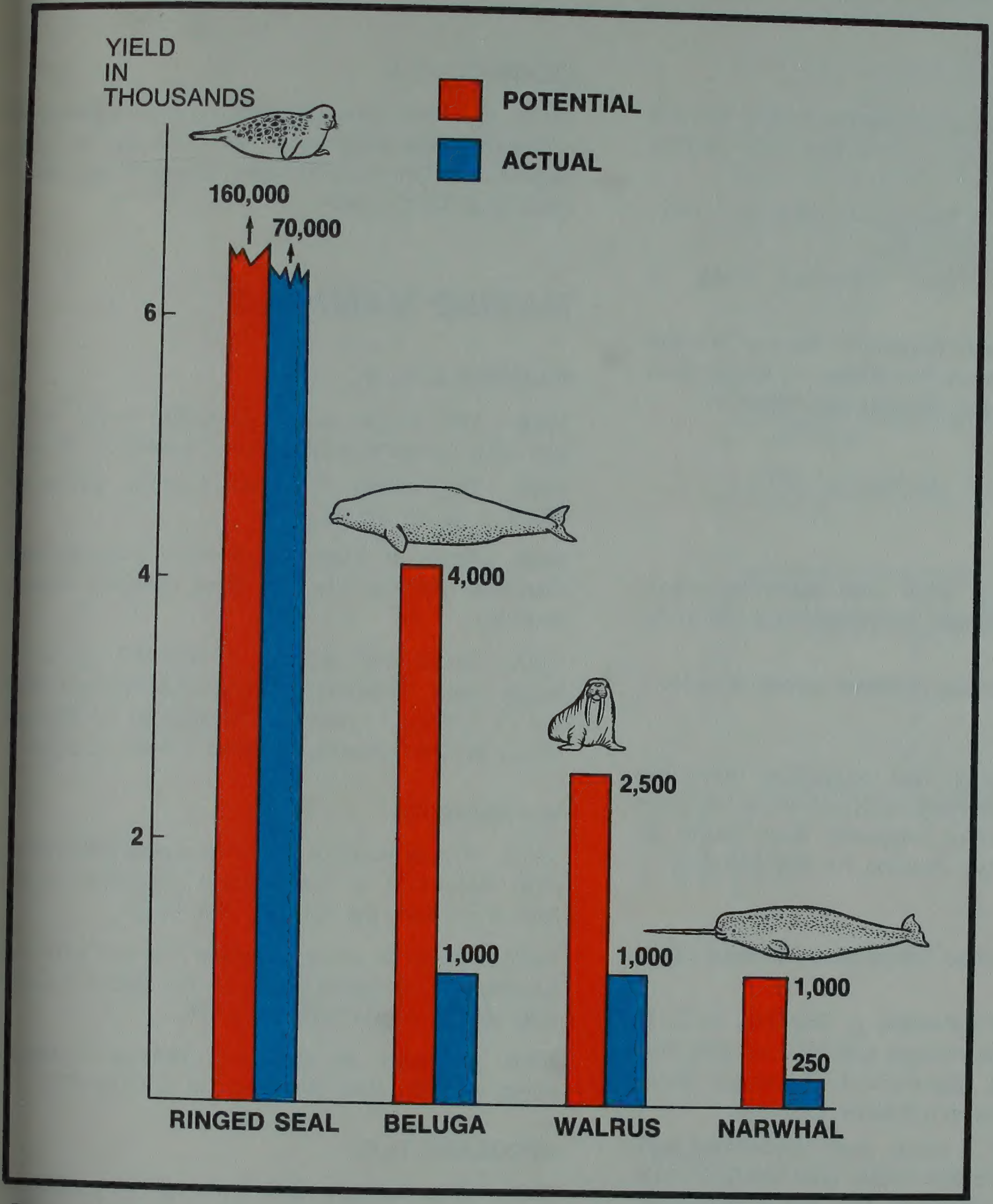
Recent industrial developments in the Arctic, particularly exploitation of oil, pose a major threat to fish and sea mammals. Dangerous oil spills may occur anywhere from wells, storage tanks, or during transportation by vessels or pipelines. With such problems in mind, the Arctic Biological Station plans to extend its marine productivity studies to provide a baseline for evaluating environmental changes, and the Freshwater Institute is planning new studies to evaluate freshwater fishery resources in the Territories.

Figure 2.



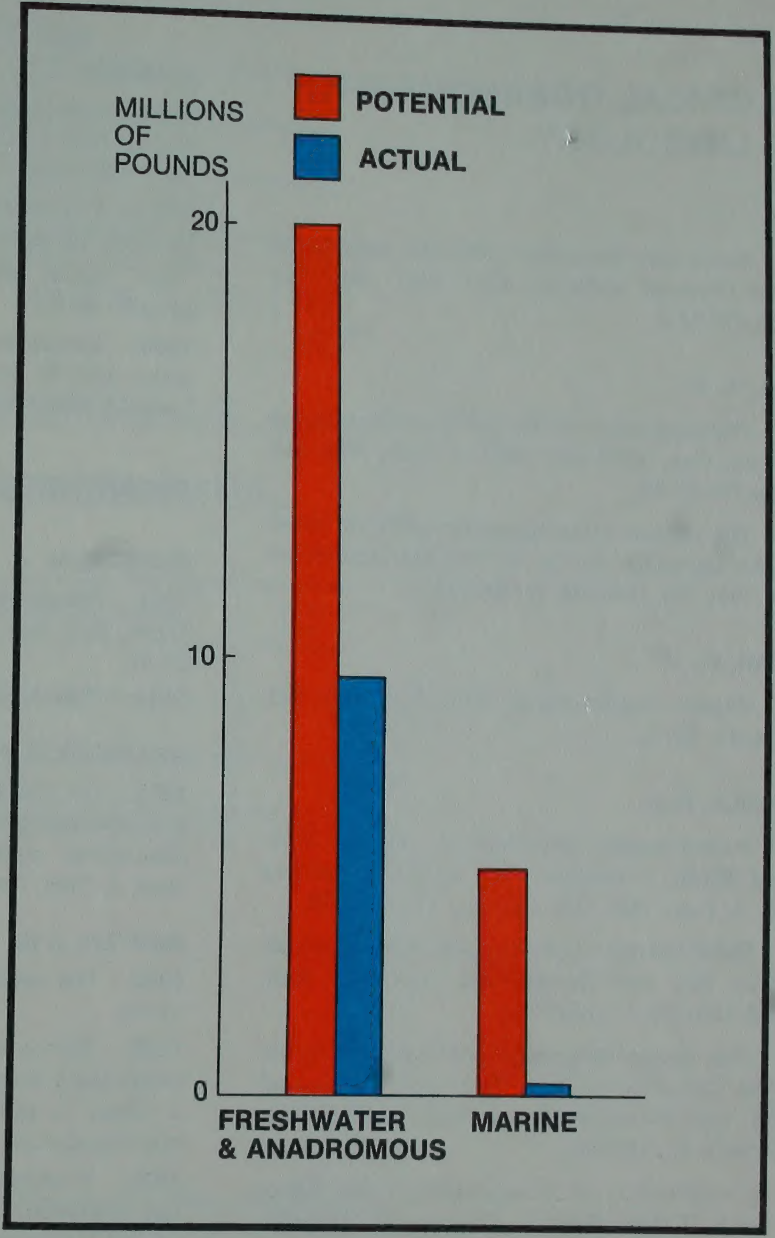
Annual fish production and fish utilization, and human population, in the Northwest Territories and in all of Canada

Figure 3.



Potential and actual annual yields of principal marine mammals in arctic Canada. Potential yields equal 10 per cent of estimated standing stock

Figure 4.



Potential and actual annual yields of freshwater and marine fish in arctic Canada

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